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Limited Consumer Attention in International Trade*

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Abstract

This paper introduces a model of limited consumer attention into an otherwise standard new trade theory model with love-of-variety preferences and heterogeneous firms. In this setting, we show that international integration needs not be welfare enhancing if the consumers' capacity to gather and process information is limited. Rather, it intensifies competition for scarce consumer attention, which causes mutual overbidding of producers in their advertising expenditures. The mutual overbidding renders advertising – which is informative in principle – wasteful and diverts purchases to imported goods at an inefficient scale. Wasteful advertising provides scope for policy intervention in the form of an advertising tax. However, if the tax instrument is not allowed to discriminate against foreign producers, it cannot eliminate inefficient diversion of consumer purchases to imports; hence it needs not be successful in securing gains from international integration in this framework.

JEL classification: D11, F12, F15, M37.

Key words: New trade theory; Heterogeneous firms; Limited attention; Advertising; Gains from trade; Love-of-variety preferences.

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1 Introduction

Since Krugman's path-breaking work more than three decades ago (Krugman, 1979, 1980), the idea that access to a greater mass of foreign varieties is the main engine for trade between industrialized countries and at the same time an important source for consumer welfare features prominently in the literature. Being initially seen as a simple shortcut for a preference-based channel through which gains from trade can materialize, the love-of-variety effect in the Krugman model has meanwhile become a doctrine of modern trade theory, which seems to be well in line with the data. For instance, Broda and Weinstein (2004, 2006) show that foreign varieties have contributed significantly to observed welfare gains in the US and other open economies over the last three decades of the 20th century.

But should we really believe that availability of more varieties *per se* renders consumers better off? There is strong evidence that the magnitude of available consumer goods is far beyond the mass of varieties that is perceived by individual agents, and this is not due to the lack of producers' effort to inform consumers. Rather, their advertising, which aims at bringing specific products to the perception of potential buyers, renders consumer attention a scarce resource in modern societies (Simon, 1971). For instance, Love and Lattimore (2009, p. 155) point out that "the average consumer in an OECD country is exposed to 3000 ads a day and will ignore most of them".[1] Schwartz (2004) speaks of a paradox of choice in this context and the literature dealing with this paradox has pointed to the overload with information as one important factor that can lower the well-being of individuals when exposed to more choices (cf. Scheibehenne et al., 2010).[2] Apart from its effects at the individual level, limitations in consumers' capacity to gather and process information about products can also have important consequences in the aggregate for the composition of goods and economy-wide welfare.[3]

It is the aim of this paper to shed light on the role of limitations in consumer attention

[1] This figure might seem to be unrealistically high at a first glance, but it is well in line with other estimates on the number of advertisements an average consumer is exposed to per day. These estimates vary between 250 and 5000 (see Anderson and de Palma, 2009).

[2] Empirical evidence on the negative consequences of more choices at the individual level is so far not conclusive.

[3] Camerer (2003) lists limited consumer attention among the key challenges for future behavioral economic research, and recent years have indeed seen a surge in research dealing with this problem. Examples include Sims (2003), Gabaix et al. (2006), Reis (2006a,b), Falkinger (2007, 2008a), or Anderson and de Palma (2009, 2012). However, despite its prominent role in many fields of the economics discipline, limited consumer attention has so far not been at the research agenda of trade economists.

in an international trade context. For this purpose, we enrich an otherwise standard trade framework with a simple, analytically tractable model of limited consumer attention that has been proposed by Falkinger (2008a). In this model, firms have to send a sufficiently strong signal relative to their competitors in order to bring their product to the attention of consumers. Sending the signal can be interpreted as an advertising investment. We model this investment as a fixed cost whose size depends on market conditions, i.e. on the mass of available consumer goods. For the trade part, we use a new trade theory model, in which consumers have love-of-variety preferences. Instead of relying on a textbook Krugman (1980) model, we choose a more elaborated framework with heterogenous firms along the lines of Melitz (2003). This allows us to distinguish between welfare effects of trade that materialize due to access to new varieties and selection effects that impact the distribution of active firms and thus the composition of consumer goods. The distinction between these two channels of welfare gains is crucial for our analysis. Limitations in the attention of consumers not only eliminate love-of-variety gains, they also distort consumption towards imports, which in models that feature selection of the most productive firms into exporting can additionally destroy the gains from the cost savings involved in trade liberalization and thus lead to welfare losses.

Advertising in our model captures two views that feature prominently in the literature. It is informative as it brings products to the perception of consumers. At the same time it plays a combative role as it aims at diverting consumers' attention from competitors to the own output, which may be socially wasteful (Marshall, 1919).[4] Crucially, advertising can only be combative in our setting if consumer attention is scarce, because only in this case the extent of advertising expenditure has an impact on a product's perception by consumers.[5] Whether attention is scarce depends on the aggregate volume of advertising

[4]We use the term 'combative advertising' in the interpretation of Garthwaite (2014), who defines it as a form of advertising that "shifts existing customers between products, and gains to advertising firms are matched by losses for competitors" (p. 76). In contrast to the term 'persuasive advertising', this avoids any reference to changes in preferences of consumers such as their intrinsic valuation of goods (cf. Belleflamme and Peitz, 2010). Aside from the informative and combative (persuasive) view, there exists a third view, which claims that advertising is complementary to a product and thus raises utility of consuming it (see Bagwell, 2007, for a literature review). In our model, advertising does not change consumer tastes (as, for instance, in Dixit and Norman, 1978), so that we can use the standard toolkit of welfare comparison to measure the efficiency effects of advertisement.

[5]This points to a crucial difference between models of informative advertising in the tradition of Ozga (1960), Butters (1977) or Grossman and Shapiro (1984) and our framework. Whereas the former strand of literature focuses on scarcity of information, we analyze competition for consumers with limited perception

provided by producers relative to the capacity of consumers to gather and process this information. We can distinguish two regimes. In the first one, the mass of available consumer goods is small, so that the total volume of information on products lies within the consumers' capacity to gather and process information. In this case, all products advertised with a minimum level of strength are perceived by consumers. We call this scenario the information-unsaturated (IU) regime. In the second regime, the consumers' capacity to gather and process information is exhausted and, in their endeavor to reach consumer attention, firms mutually overbid their advertising expenditures until firm exit has brought the mass of available products in accordance with the perception constraint of consumers. We refer to this scenario as the information-saturated (IS) regime.

The distinction of the two information regimes is important when studying the consequences of trade liberalization, which is modeled as a reduction in iceberg transport costs between two symmetric countries. Thereby, the IU-regime serves as a benchmark of our analysis. In this regime, attention is not scarce; advertising is informative, as it brings (domestic and foreign) products to the perception of consumers, but it does not play a combative role, because consumers have free information-processing capacity and perceive any product advertised to them. Hence, all firms advertise with minimum strength before and after the fall in transport costs, and our model reproduces the standard result of gains from trade in the Melitz framework. If all firms export, these gains from trade materialize since less resources are used for the transportation of goods and consumption therefore increases. As in Krugman (1980) there is neither a change in the mass of available varieties nor a change in the composition of producers, provided that the trading partner are identical. Accordingly, a fall in the transport costs cannot exacerbate the already fierce competition for scarce consumer attention in an IS-regime, so that in a setting, in which all firms export, gains from trade also exist when the capacity of consumers to gather and process information is exhausted.

Things are different if there is partitioning of firms by their export status. In this case, gains from trade arise due to access to a larger mass of consumed product varieties and a positive compositional effect – triggered by exit of the least productive firms and entry of the most productive ones in the export market. However, the love-of-variety gains from imports cannot be fully exploited if consumer attention is scarce. The decline in transport costs would make new foreign varieties accessible. But consumers cannot process addi-

capacity, which in turn may render advertising combative.

tional product information, given their perception constraint. This intensifies competition for scarce consumer attention and induces firms to mutually overbid their advertising expenditures.[6] The overbidding is wasteful because increased advertising efforts of firms do not increase the amount of product information in the mind of consumers beyond the limit set by their perception constraint. Despite its combative character in an IS-regime, the increase in firm-level advertising needs not be detrimental for welfare; import competition and more intensive advertising induce exit of the least productive producers and thus give way for newly imported varieties in consumer perception that are produced with higher labor productivity than the displaced domestic ones. This generates a selection effect which impacts the composition of consumer goods in a similar way as the selection effect in an IU-regime. However, with the mass of perceived and consumed varieties being limited by the consumers' capacity to gather and process information, the compositional effect is amplified and diverts consumption to imports relative to an IU-regime. If transport costs are significant, the inefficient level of imports and the waste of resources due to combative advertising can generate welfare losses from economic integration in an IS-regime with partitioning of firms by their export status.[7]

Welfare losses in the IS regime with partitioning of firms by their export status leave scope for policy intervention. A natural instrument for the policy intervention is taxation of advertising, because it targets the waste of resources triggered by the competition of

[6]The link between iceberg transport costs and advertising expenditure in an information-saturated environment relates our model to Arkolakis (2010), who considers a heterogeneous firms model of trade, in which marketing expenditures determine a firm's penetration of a market (i.e. the share of consumers, this firm can reach with its output). However, aside from the link between transport costs and advertising expenditure, the two models differ significantly in both their focus and their modeling strategy. In particular, Arkolakis assumes that firms can raise their advertising expenditures to increase the radius of information and to address more consumers. Whereas allowing for such gradual adjustments in the advertising strength would generate the realistic pattern that larger firms have higher advertising expenditures, it would not provide additional relevant insights regarding the principle role that limited consumer attention plays for welfare or the role of firm-level adjustments in advertising spending for the welfare implications of trade. Therefore, we consider a simpler cost structure and assume that the information provided by firms is a public good, once firms advertise with a sufficient minimum strength to be recognized at all.

[7]Egger and Kreickemeier (2009) distinguish two supply-side welfare effects that arise from importing. On the one hand, there is a negative *lost-in-transit* effect caused by goods melting away when being shipped to a foreign country and, on the other hand, there is a positive *export-selection* effect since it is the most productive foreign firms who export, so that in a symmetric world the average imported good is produced with a better technology than the average domestic product. If transport costs are high, the former effect dominates and importing is associated with a waste of resources.

firms for scarce consumer attention. Being interested in the principle possibility to render trade liberalization a success also in an IS-regime, we abstract from any imperfections that may arise due to unilateral tax setting in a non-cooperative policy game and focus on coordinated (symmetric) forms of policy intervention. Furthermore, in line with WTO rules we consider non-discriminatory taxation that treats domestic and foreign firms identically. In this case, an optimal tax on advertising expenditure can indeed eliminate the problem of wasteful advertising. However, it is of no help for relaxing the consumers' perception constraint in an IS-regime and therefore cannot eliminate the inefficient diversion of consumption towards imported goods. Thus, the optimal tax does not necessarily guarantee that consumers are better off after trade liberalization. Put differently, since scarcity of attention limits the love-of-variety gains in an IS-regime with partitioning of firms by their export status, trade liberalization may reduce welfare, even if taxation eliminates excessive social costs of combative advertising. This distinguishes our analysis from other advertising models that do not account for limitations of consumer attention, and it sets the stage for a provocative claim: In a world with limited consumer attention a policy instrument that aims at securing gains from trade may have to discriminate against foreign producers, in order to correct the inefficient diversion of purchases towards imports.

In a further step of our analysis we investigate advancements in information and communication technologies (ICT) that reduce the costs of advertising. We conduct two comparative-static exercises. In the first one, we consider a general improvement in ICT that lowers domestic and foreign advertising costs symmetrically. In the second one, we consider an advancement in ICT that extends the range of advertising and thus reduces the extra costs of reaching foreign consumers with a given domestic investment into advertising. In this case, the ICT advancement is export biased. We show that both types of technology improvement are efficiency-enhancing and thus welfare-improving in an IU-regime, irrespective of whether all or only a subset of firms export. Things are different in an IS-regime. If the consumers' capacity to gather and process information is exhausted, a general advancement in ICT renders firm entry more attractive, and firms in their endeavor to receive consumer attention mutually overbid their advertising efforts. This aggravates the problem of wasteful advertising and eats up the cost reduction per unit of advertising investment, so that welfare remains unaffected by the technology improvement. The outcome is even less encouraging in the case of an export-biased advancement in ICT. In a scenario with partitioning of firms by their export status, a relative decline in the fixed costs of exporting reinforces the problem of consumer purchases being diverted to imports

with negative welfare consequences. If optimally designed, a non-discriminatory advertising tax eliminates wasteful advertising and secures the gains from general advancements in ICT, irrespective of the information regime. However, the tax does not eliminate the inefficient diversion of consumption towards imports and needs therefore not be successful in securing welfare gains of export-biased advancements in ICT in the IS-regime.

In a final step, we give up the restrictive assumption that all consumers like and purchase all goods. Instead, we assume that certain products are worthless from the perspective of some consumers and perceiving these products therefore does not induce them to purchase these goods (see Krugman, 1980, for a similar exercise). This introduces the notion of ideal 'varieties of goods' into an otherwise standard model, in which consumers have love-of-variety preferences and allows us to formalize the idea of 'junk', which we associate with useless advertising, i.e. the advertisement of products that are worthless for a consumer. We show that the existence of junk leads to a distraction of consumers' attention, and this gives rise to an additional form of welfare loss. However, the main insights from our analysis regarding the consequences of trade for welfare remain unaffected by this modification.[8]

The main message from our analysis is that limitations in consumer attention can change key insights from the existing trade literature in a qualitative way and may trigger welfare losses from international integration. Of course, the finding that trade may lower welfare in a setting with market distortions is not new (see Markusen, 1981; Newbery and Stiglitz, 1984, for two prominent early examples). However, it is less immediate in the context of the Melitz (2003) model. As pointed out by Baldwin (2005), there are two counteracting externalities in this framework – both related to firm entry. On the one hand, firms do not consider their negative impact on competitors, so that producers end up being too small and too numerous from the perspective of production efficiency. On the other hand, firms do not account for the extra consumer surplus of adding an additional variety to the consumption basket and, viewed on its own, this implies that too

[8]One may be tempted to conclude that consumers can avoid distraction of their attention by simply ignoring junk. However, identifying junk itself is time-consuming. To visualize the magnitude of this effect, we can conduct a simple thought experiment. Relying on estimates from Rao and Reiley (2012) consumers spend about 5 seconds to deal with a 'spam' email, where spam is associated with the illegal form of advertisement in unsolicited email. Being exposed to 3000 adds a day (cf. Love and Lattimore, 2009) and assuming that at least one fourth of these adds are junk, consumers spend an hour a day for dealing with useless advertising. This may be an extreme example. Yet, it illustrates that the distraction of attention due to junk can be sizable.

few firms are active. The two externalities exactly offset each other in the Melitz (2003) model, rendering the market equilibrium allocationally efficient, despite the monopolistic price setting of firms.[9] Therefore, international integration simply alleviates a quantitative restriction, which must be welfare improving (see Krishna and Panagariya, 2000). The limited attention of consumers gives rise to two distortions that are absent in the Melitz (2003) model. On the one hand, combative advertising affects the resource base; less resources are left for productive use. On the other hand, the capacity to gather and process information confines the maximum volume of products that can be perceived by consumers. This closes the positive externality of firm entry on consumer welfare and diverts consumption towards imported goods, thereby rendering the market outcome no longer allocationallly efficient. Since in an information-saturated regime both distortions are increased by trade, the resulting welfare losses may outweigh the benefits from market integration.

The paper is organized as follows. Section 2 briefly summarizes the main ingredients of the Melitz (2003) model. Section 3 introduces limited attention and characterizes the trade equilibrium in the two information regimes. Also, the impact of a reduction in the iceberg transport cost parameter on welfare is analyzed in this section. In Section 4, we study the role of taxation of advertising. Section 5 deals with advancements in the information and communication technology. Section 6 shows how the model can be modified to account for 'junk' as an important source of attention distraction. Section 7 concludes with a summary of the most important results and provides a discussion to what extent the insights from our model can be useful for guiding future empirical research.

2 A model of trade and heterogeneous firms

We conduct our analysis in a Melitz (2003)-type framework with trade between two symmetric countries, whose economies are described in the subsequent. Consumers have Dixit and Stiglitz (1977) love-of-variety preferences for horizontally differentiated goods. Max-

[9] Of course, this result does not depend on the assumption of heterogeneous firms. It also holds for the Krugman (1980) model, which features homogeneous producers. As pointed out in the literature the allocational efficiency in these types of models materializes due to the specific nature of external scale economies (Egger et al., 2015), and the assumption of a single sector of production, which implies that all firms are subject to the same price distortion (Benassy, 1996). Furthermore, Dhingra and Morrow (2014) show that the market outcome is no longer allocationally efficient if the elasticity of substitution is endogenous, since relative prices are also distorted in this case.

imization of utility $V = \left[\int_{\omega\in\Omega} x(\omega)^{(\sigma-1)/\sigma} d\omega\right]^{\sigma/(\sigma-1)}$ – subject to a binding budget constraint – gives an isoelastic demand function for each variety ω:

$$x(\omega) = \frac{I}{P}\left(\frac{p(\omega)}{P}\right)^{-\sigma}, \tag{1}$$

where $\sigma > 1$ denotes the constant elasticity of substitution between the different varieties in consumers' utility, which equals the price elasticity of demand in this model. I is aggregate income, $p(\omega)$ is the consumer price for variety ω, and P is a true cost-of-living price index: $P = \left[\int_{\omega\in\Omega} p(\omega)^{1-\sigma} d\omega\right]^{1/(1-\sigma)}$, with Ω being the set of differentiated consumer goods.

The economy is populated by L workers, each supplying one unit of labor in a perfectly competitive market. Labor is the only factor of production and serves as numéraire in the subsequent analysis, implying that the wage rate is normalized to one. Labor input in each firm is an affine linear function of output q: $l = f_t + q/\phi$, where ϕ is firm-specific labor productivity and f_t denotes the fixed labor requirement for overhead services, with $f_t = f$ if a firm is only active domestically and $f_t = f + f_x$ if a firm additionally exports. Each active firm produces a single variety and is a monopolist in the market for this variety. Facing demand (1), firms maximize their profits by charging a constant markup, $\sigma/(\sigma-1)$, over their marginal costs, which are $1/\phi$ in the home market and τ/ϕ in the foreign market, with $\tau > 1$ capturing iceberg transport costs for shipping goods internationally.

The mass of available varieties depends on firm entry, which is modeled as in Melitz (2003). In particular, we consider an unbounded pool of potential entrants who decide upon an initial investment f_e (in units of labor). This investment provides access to a productivity lottery, in which firms draw their ϕ-level from the common distribution $G(\phi) = 1 - \phi^{-k}$, with $k > \sigma - 1$.[10] Each firm has only one draw and f_e is immediately sunk. After the lottery, firms decide upon production. If they start production, they make domestic profits $\pi(\phi) = r(\phi)/\sigma - f$ in each period in which they are active, with $r(\phi)$ denoting revenues from local sales that are an increasing function of ϕ.[11] In addition, firms

[10] Assuming that the productivity distribution is Pareto has evolved as industry standard in the literature on heterogeneous firms. This assumption is attractive from the perspective of analytical tractability and has considerable empirical support (Axtell, 2001; Del Gatto et al., 2006). Condition $k > \sigma - 1$ is needed to ensure an interior equilibrium with finite values of key aggregates (see Baldwin, 2005).

[11] In view of (1) and constant markup pricing, we have

$$r(\phi) = p(\phi)x(\phi) = \frac{I}{P^{1-\sigma}}\left(\frac{1}{\phi}\,\frac{\sigma}{\sigma-1}\right)^{1-\sigma}.$$

can export to a *symmetric* trading partner, which generates profits $\pi_x(\phi) = \tau^{1-\sigma} r(\phi)/\sigma - f_x$. With profits depending positively on a firm's productivity, we can characterize a productivity cutoff that separates active from inactive producers. This productivity cutoff, ϕ^*, is determined by the *zero cutoff profit condition* $\pi_t(\phi^*) = 0$, where $\pi_t(\phi)$ denotes total (domestic plus foreign) per-period profits of a firm with productivity ϕ.

Firms have an infinite horizon and face an exogenous destruction probability which forces a share δ of producers to exit in each time period. Then, abstracting from time discounting, in the steady-state equilibrium new firms will enter the productivity lottery in each period until the expected present value of profits, $\bar{\pi}_t/\delta$, multiplied by the probability of a successful draw, $1 - G(\phi^*)$, equals the lottery participation cost, f_e. This gives the *free entry condition*

$$\bar{\pi}_t = \frac{\delta f_e}{(\phi^*)^{-k}}, \tag{2}$$

which establishes a relationship between average (per-period) profits $\bar{\pi}_t$ and cutoff productivity ϕ^*.

The zero-cutoff profit condition provides a further link between average profits and the cutoff productivity, with the specific form of this link depending on how many firms self-select into export status. Provided that the beachhead costs for entering the foreign market are sufficiently high relative to domestic ones, i.e. $f_x/f > \tau^{1-\sigma}$, the model leads to partitioning of firms by their export status, with only the most productive firms serving both domestic and foreign consumers. In this case, the productivity of the marginal exporter, ϕ_x^*, is larger than the productivity cutoff in the domestic market, ϕ^*, and the proportion of firms that export is given by $\chi \equiv (\phi_x^*/\phi^*)^{-k} = [(f_x/f)\tau^{\sigma-1}]^{-k/(\sigma-1)} < 1$.[12] If $f_x/f \leq \tau^{1-\sigma}$, all firms export, establishing $\chi = 1$. Adding up profits over all active producers, we get for average (per-period) profits in the open economy (see the appendix):

$$\bar{\pi}_t = \left(1 + \chi \frac{f_x}{f}\right) \frac{(\sigma - 1) f}{k - \sigma + 1}. \tag{3}$$

The latter equation is based on producers with $\phi \geq \phi^*$ and thus directly related to $\pi_t(\phi^*) = 0$. Hence, it represents a *modified* zero-cutoff profit condition.

Furthermore, with a constant share $(\sigma - 1)/\sigma$ of revenues used for financing variable labor input, operating profits are given by $r(\phi)/\sigma$.

[12] Exporting in this model is more attractive for firms with higher productivity. Partitioning by export status requires that the least productive non-exporter is characterized by $r(\phi^*)/\sigma = f$, whereas the least productive exporter is characterized by $\tau^{1-\sigma} r(\phi_x^*)/\sigma = f_x$. Hence, $\phi_x^* > \phi^*$ and thus $\chi < 1$, if $f_x/f > \tau^{1-\sigma}$.

Together, Eqs. (2) and (3) determine the productivity cutoff, ϕ^*, and average profits, $\bar{\pi}_t$. Furthermore, aggregate labor demand must equal total labor supply, i.e. $\sigma M(\bar{\pi}_t + f + \chi f_x) = L$, where M denotes the mass of producers headquartered in a country.[13] Using this and Eq. (3) in $M_t = M(1+\chi)$, we can solve for M_t, which is the total mass of (domestic and foreign) varieties that are available in the market. We have:

$$M_t = \frac{1+\chi}{1+\chi f_x/f} \frac{L(k-\sigma+1)}{f\sigma k}. \tag{4}$$

In a model in which consumers have love-of-variety preferences, the mass of available consumer goods is a key determinant of a consumer's indirect utility (welfare), U, which in our framework equals the real wage, w/P, and, as formally shown in the appendix, is given by

$$U = \begin{cases} \dfrac{\sigma-1}{\sigma}\left[\dfrac{L}{\sigma f}\right]^{\frac{1}{\sigma-1}}\left[\left(1+\chi\dfrac{f_x}{f}\right)\dfrac{(\sigma-1)f}{(k-\sigma+1)\delta f_e}\right]^{\frac{1}{k}} & \text{if} \quad f_x/f > \tau^{1-\sigma} \\ \dfrac{\sigma-1}{\sigma}\left[\dfrac{L\left(1+\tau^{1-\sigma}\right)}{\sigma f(1+f_x/f)}\right]^{\frac{1}{\sigma-1}}\left[\left(1+\dfrac{f_x}{f}\right)\dfrac{(\sigma-1)f}{(k-\sigma+1)\delta f_e}\right]^{\frac{1}{k}} & \text{if} \quad f_x/f \leq \tau^{1-\sigma} \end{cases}. \tag{5}$$

This completes the characterization of the trade equilibrium.

3 Limited attention in an open economy

We now extend the basic trade model of Section 2 to one with limited consumer attention. Following Falkinger (2008a), we use a key insight from psychological research on human information processing as the cornerstone of our attention model: "[C]apacity limits *and* perceptual gating both characterize human perceptual processing" (Pashler, 1998, p. 224). This implies a fundamental bottleneck for a firm that tries to reach consumer attention. One may think about this bottleneck in terms of Kahneman's (1973) dual-task approach. Individuals have a certain amount of perceptual capacity and the way in which a specific

[13] In view of constant markup pricing, a share $(\sigma-1)/\sigma$ of total revenues, R, is spent for variable labor input in production, whereas a share $1/\sigma$ remains for fixed total per-period labor input in overhead services, $M(f+\chi f_x)$, and aggregate profits $M\bar{\pi}_t$. Hence, $R = \sigma M[\bar{\pi}_t + f + \chi f_x]$ and, because of $w = 1$, variable labor input in production is given by $(\sigma-1)M[\bar{\pi}_t + f + \chi f_x]$. Since each period δM firms must be replaced to keep M at the steady state level, we have in addition $\delta M f_e/(1-G(\phi^*))$ units of labor required by new entrants for participating in the productivity lottery. Adding up the three components of labor demand and using (2), we obtain for the aggregate labor demand $\sigma M[\bar{\pi}_t + f + \chi f_x]$.

signal from advertising is processed by a consumer depends on the capacity left by the other signals to which the consumer is exposed. If no capacity is left the signal is ignored. The perceptual gate determines which signals are processed with priority. It is assumed that the strongest signals come first. As a result, two regimes are possible: As long as total signal exposure lies below the consumer's capacity constraint, there is no competition for scarce perceptual resources and thus no interference between different signals. If however the mass of signals to which a consumer is exposed exceeds the perceptual capacity, signals whose strength lies below a certain threshold are crowded out.

As in Falkinger (2008a), we account for the consumers' perceptual constraint by assuming that, irrespective of the mass of actually supplied and advertised varieties, consumers cannot process information of more than $\bar{M}$ goods, and hence purchase $M_t \leq \bar{M}$ varieties in equilibrium.[14] Firms, on the other hand, while taking the capacity constraint as given, can invest into advertising in order to bring their products to consumers' attention.[15] Thereby, firms must advertise with a sufficient strength in order to pass the perceptual gate of consumers. Let the minimum strength of advertising that makes a product visible to consumers be denoted by $\rho_{min} \geq 1$. Even without competition for attention a minimum level of advertising, normalized to $\rho_{min} = 1$, is required to make consumers aware of a product and its characteristics.

If $M_t < \bar{M}$ producers enter and advertise their product with the minimum strength $\rho_{min} = 1$, all of these products can be perceived by consumers, and hence the capacity constraint of consumers to gather and process information is not a limiting factor. In contrast, if more than $\bar{M}$ firms would find it profitable to enter and advertise with the minimum strength $\rho_{min} = 1$, the perception constraint limits the mass of products that can be perceived by consumers. Recognizing that only those $\bar{M}$ firms which send the strongest signal can attract consumers, firms therefore increase their advertising effort. Higher advertising requirements mean rising overhead costs so that starting production is no longer attractive for the least productive firms. Firms mutually overbid their advertising

[14] The assumption of a definite upper bound for the mass of perceived products is clearly a drastic simplification. In reality, $\bar{M}$ may respond to stimulus exposure. But this would not change the main conclusions of this paper qualitatively. The essential point is that scarcity of attention diminishes the love-of-variety gains from additional imports and triggers competition for attention with negative externalities.

[15] Advertising provides accurate information about the relevant product characteristics. Unlike advertising models based on the pioneering work of Ozga (1960) and Butters (1977), and, in particular, in contrast to Arkolakis (2010), the advertised information is a public good, which is equally available for all consumers in a certain country, if they pay attention to it.

expenditures up to the point at which the mass of active firms is in line with the consumers' perceptual constraint $\bar{M}$. In sum, the competition for attention drives up the minimum strength of advertising that is required to pass the perceptual gate. Hence, the equilibrium value of ρ_{min} is endogenously determined by the condition $M_t = \bar{M}$ and depends on the scarcity of attention. Since individual firms in our model have measure zero, they take ρ_{min} as given.[16] Moreover, if $M_t = \bar{M}$ no active firm has an incentive to deviate from ρ_{min}. On the one hand, lowering its advertising strength cannot be profitable for a firm that makes positive profits when advertising at strength ρ_{min}, because its product would no longer be perceived by consumers and its sales would fall to zero. On the other hand, there are no other benefits of advertising for firms in our model than passing the perceptual gate of consumers;[17] hence firms do not have an incentive to advertise at a strength higher than ρ_{min}.

Limited consumer attention renders advertising an important fixed cost factor. A tractable specification that integrates this into our trade model is

$$f = a\rho^{\alpha}, \qquad f_x = a_x\rho^{\alpha}, \qquad \alpha > 0. \tag{6}$$

Thereby, focusing on a parameter domain with $a \geq a_x$ is meaningful in our context. For instance, the borderline case of $a_x = 0$ can be associated with an information and communication technology (ICT) that provides world-wide dissemination of information, such that firms do not have to bear additional costs of bringing their product to the attention of foreign consumers. In this case, the beachhead costs of entering the foreign market are zero, implying that all firms engage in exporting, and hence there is no selection of just the best firms into export status. In the other limiting case of $a_x = a$, the range of ICT is confined to the local market and firms have to promote their products separately in the two economies. In the intermediate case of $a_x \in (0, a)$, on which we focus in the subsequent analysis, part of the advertising investment, as for instance the set up of a principle advertising strategy, has a global character, while the other part is location-specific, for instance due to different languages in the two countries. With $a_x/a < 1$ the mass of available varieties cannot decrease in the process of trade liberalization. By

[16] See Hefti (2013) for an analysis of oligopolistic competition under limited attention.

[17] This assumption simplifies our model enormously and helps us focusing on the role of limited consumer attention – instead of changes in consumer behavior in response to marketing. The assumption is akin to Bagwell's (2007) conclusion from reviewing the advertising literature that "advertising often entails diminishing returns beyond a threshold level, where the threshold level varies across circumstances and may be small" (p. 1734).

suppressing country indices of ρ, we acknowledge the symmetry of countries, which implies that exporters face the same mass of competitors and thus the same ρ_{min} at home and abroad. Hence, exporters must advertise with the same strength in their domestic and their foreign market if they want to bring their product to the attention of consumers.

In order to shed light on the role of limited attention in interaction with trade, we substitute Eq. (6) into Eq. (4). This gives us

$$M_t = \frac{1+\chi}{1+\chi a_x/a} \frac{L(k-\sigma+1)}{a\rho^{\alpha}\sigma k} \equiv RHS(\rho), \tag{4'}$$

with $dRHS/d\rho = -RHS\alpha/\rho < 0$. M_t is the mass of firms that find it profitable to seek the attention of consumers at a given advertising strength ρ. Thus, $RHS(\rho)$ can be interpreted as 'demand for consumer attention' resulting from decentralized firm entry decisions. The stronger is the required advertising signal ρ, the larger are fixed costs f_t, and the less firms find it attractive to serve consumers. The 'supply of attention' is determined by the consumers' capacity to gather and process information. As long as this capacity is not exhausted, attention supply is perfectly elastic. In contrast, if the capacity is exhausted, attention supply is inelastic and given by $\bar{M}$. Figure 1 illustrates the link between the mass of attention-seeking products, M_t, and firm-level advertising expenditure, ρ. The equilibrium values of these two variables are determined by the intersection of the attention demand and the attention supply loci.

Two cases can be distinguished. If the right-hand side of Eq. (4') is represented by schedule RHS, consumer attention is not scarce and the economy is in an *information-unsaturated* (IU) regime. The equilibrium is represented by point A in Figure 1. It is characterized by $\rho = 1$ and $M_t = RHS(1) < \bar{M}$. In point A, there is no reason for firms to raise their advertising strength above $\rho = 1$, because this would just increase fixed costs without a positive effect on the firm's operating profit. Things are different if the right-hand side of Eq. (4') is represented by schedule RHS'. In this case, at $\rho = 1$ more firms will enter than consumers can perceive, given the perception constraint $\bar{M}$. This describes an *information-saturated* (IS) regime, in which firms raise their strength of advertising above $\rho = 1$ in order to attract consumers' attention. Mutual overbidding of advertising effort drives up fixed costs and establishes an equilibrium at A', where the decentralized entry decisions are brought into accordance with the perception constraint of consumers. Equilibrium point A' is characterized by $M_t = \bar{M}$ and an advertising strength $\rho > 1$ that is implicitly determined by $\bar{M} = RHS(\rho)$. Similar to Melitz (2003) the equilibrium in both information regimes generates a ranking such that only the most productive firms

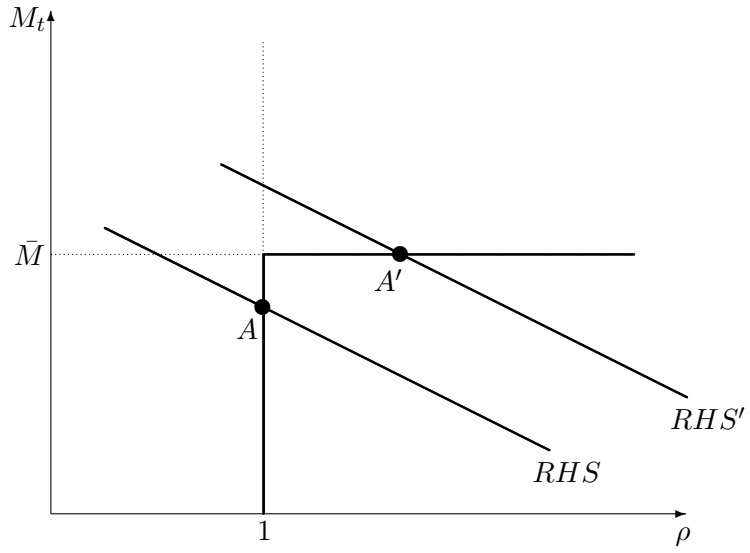

Figure 1: Advertising in an IU- and in an IS regime

start production. Less productive firms stay out of the market as setting their advertising expenditures to a level which makes them visible for consumers would induce negative profits.

Whether the outcome of decentralized firm entry decisions lies in the IU-regime or the IS-regime depends on exogenous parameters. In particular, from inspection of Eq. (4′) it is obvious that the position of the RHS-locus depends on the share χ of exporting firms, which in turn is given by

$$\chi = \begin{cases} \left(\frac{a_x}{a}\right)^{-\frac{k}{\sigma-1}} \tau^{-k} & \text{if} \quad a_x/a > \tau^{1-\sigma} \\ 1 & \text{if} \quad a_x/a \leq \tau^{1-\sigma} \end{cases}. \tag{7}$$

This renders the iceberg transport cost parameter, τ, and the two ICT parameters, a and a_x, key determinants of the equilibrium information regime. Changes in these parameters and their consequences for the scarcity of consumer attention are in the center of our analysis. Beyond that, we are interested in the differential effect that changes in these variables exert on consumer welfare U under the two information regimes. The next two subsections look on the role of iceberg transport cost parameter τ. We start with a comparative-static analysis of transport cost changes in an IU-regime in Subsection 3.1

and discuss the IS-regime in Subsection 3.2. A comparative-static analysis of changes in ICT is deferred to Section 5.

3.1 Falling transport costs in an IU-regime

If $M_t < \bar{M}$, the limited attention model in this paper corresponds to a standard heterogeneous firms model along the lines of Melitz (2003), with production and exporting fixed costs being given by $f = a$ and $f_x = a_x$, respectively. Differentiating (4′) with respect to τ yields

$$\frac{dM_t}{d\tau} = \frac{(1 - a_x/a)M_t}{(1+\chi)(1+\chi a_x/a)} \frac{d\chi}{d\tau}. \tag{8}$$

If $a_x/a < \tau^{1-\sigma}$ induces all firms to export, a marginal decline of the iceberg transport cost parameter does not affect the firms' decision to enter the domestic or the export market and therefore leaves the mass of available consumer goods unaffected. This result is akin to the finding by Krugman (1980) that iceberg "transportation costs have no effect on the number of firms" (p. 954) in his textbook model of new trade theory with homogeneous firms. This invariance result does not depend on the assumption of homogeneous firms, but hinges on the specific property of the Krugman model that all firms are affected symmetrically by changes in the transport cost parameter. In the parameter domain $a_x/a > \tau^{1-\sigma}$ we have $\chi < 1$; only a subset of firms exports and benefits from a decline in the iceberg transport cost parameter. Intuitively, lower transport costs make exporting more attractive inducing additional firms to enter the export market. From the perspective of consumers, this gives access to newly imported foreign goods, which raises M_t. At the same time, the stronger competition for labor triggered by the new domestic exporters leads to exit of the least productive local producers, which lowers M_t. With $a > a_x$, it is the first effect that dominates, so that a fall in per unit transport costs raises the mass of available product varieties (see Eq. (8)).

A decline in τ lowers the costs and thus the resources used for shipping goods across borders. This exerts a welfare stimulus at the intensive margin, since incumbent exporters sell a larger share of their products in the market. The intensive margin is instrumental for gains from trade if all firms export (due to $a_x/a < \tau^{1-\sigma}$). This can be verified by setting $\rho = 1$ and differentiating (the second line in) Eq. (5) with respect to τ:

$$\frac{dU}{d\tau} = \frac{\tau^{-\sigma}U}{1+\tau^{1-\sigma}} < 0 \quad \text{if} \quad a_x/a < \tau^{1-\sigma}. \tag{9}$$

If only the most productive firms export (due to $a_x/a < \tau^{1-\sigma}$), a decline in the transport cost parameter additionally increases the share of exporters and leads to exit at the lower bound of the productivity distribution, thereby increasing cutoff productivity level ϕ^* and making the average domestic producer more productive. These adjustments at the extensive margins of firm activity generate gains from trade in a model featuring selection of firms (into the domestic as well as the export market). The respective welfare gains can be computed by setting $\rho = 1$ and differentiating (the first line in) Eq. (5) with respect to τ:

$$\frac{dU}{d\tau} = \frac{(a_x/a)U}{k(1+\chi a_x/a)} \frac{d\chi}{d\tau} < 0 \quad \text{if} \quad a_x/a > \tau^{1-\sigma}. \tag{10}$$

For sorting out the different channels through which gains from trade materialize in new trade theory models with and without selection of firms into exporting, it is noteworthy that in the model variant with $\chi < 1$, total transport cost expenditures may increase or decrease after a decline in τ. On the one hand, more goods are imported; on the other hand, each unit can be transported at a lower cost. If total transport costs rise, any welfare gain must come from the increased variety of goods consumed or the better composition of domestic firms. This is different in the model variant, in which all firms export. Lacking gains from access to additional varieties or from an improvement in the composition of domestic producers, welfare increases only because of declining transport costs: Less resources are lost en route to the foreign country, allowing aggregate consumption to increase.

Whereas these effects are well-known from existing work on heterogeneous firms in open economies, it is a novel feature of our analysis that, in a scenario with partitioning of firms by their export status, a fall in the transport cost parameter brings the open economy closer to the IS-regime, which we analyze in detail in the next subsection.

3.2 Falling transport costs in an IS-regime

If the capacity of consumers to gather and process information is exhausted, the mass of perceived varieties is fixed by $\bar{M}$ and the strength of advertising is determined by Eq. (4′), when accounting for $M_t = \bar{M}$. Applying the implicit function theorem, we obtain

$$\left.\frac{d\rho}{d\tau}\right|_{M_t=\bar{M}} = \frac{\rho(1-a_x/a)}{\alpha(1+\chi)(1+\chi a_x/a)} \frac{d\chi}{d\tau}. \tag{11}$$

This illustrates that changes in the iceberg transport cost parameter can only have an impact on the strength of advertising if they lead to adjustments at the extensive margin

of trade, i.e. if and only if the composition of exporters changes. The reason is that only in this case, changes in τ alter the incentives of firms to bring their products to the attention of foreign consumers. Therefore, we can focus on the parameter domain that leads to partitioning of firms by their export status, and thus on $a_x/a > \tau^{1-\sigma}$ in the subsequent analysis. In this case, a decline in the transport cost parameter renders exporting more attractive and the share of exporters, $\chi = (a_x/a)^{-k/(\sigma-1)}\tau^{-k}$, rises. In an IU regime, the expansion of exports at the extensive margin, would raise the mass of available varieties in either economy *ceteris paribus*. However, with a binding perception constraint, there is no market for additional varieties, because consumers do not pay attention to them. Hence, in order to attract consumers' attention firms mutually overbid their advertising strength, ρ, which induces a proportional increase of fixed costs in both the domestic and the foreign market.[18] The higher fixed costs reinforce firm exit at the bottom of the productivity distribution, implying that M falls stronger and ϕ^* rises by more than in an IU-regime. A new equilibrium is reached if sufficiently many non-exporters have left the market, such that the remaining firm population is consistent with the constraint $M_t = (1+\chi)M = \bar{M}$, where the declining unit costs of transport have increased the share of exporters, χ. In the new equilibrium, all firms again advertise with the same strength, which, however, is higher than it was prior to the fall in transport costs. This can easily be seen by means of Figure 1, in which a decline in τ corresponds to an upward shift of RHS'.

Whereas in an IS-regime a fall in transport costs raises firm-level advertising expenditures, with a negative externality on competitors, this does not necessarily mean that economy-wide advertising expenditures increase as well. The reason is that the least productive firms exit the market and stop advertising at all. Noting that total advertising expenditures are given by $M_t a\rho^{\alpha}(1 + \chi a_x/a)/(1 + \chi)$ and accounting for Eq. $(4')$, we find that the two opposing effects exactly cancel out, so that total advertising expenditures remain unaffected by a fall in the iceberg transport cost parameter. Still, the increase in firm-level advertising implies a waste of resources, because the same content of information could be provided at lower advertising expenditures. The minimum sig-

[18] This points to a crucial difference between the IU-regime and the IS-regime if there is partitioning of firms by their export status. In the former regime, fixed costs are exogenous and the mass of consumed varieties responds to a fall in trade costs, as in the Melitz (2003) model. In the latter regime, the mass of consumed varieties is constant, and hence fixed costs have to adjust when trade costs fall in order to bring firms' demand for attention in accordance with the consumers' capacity constraint to gather and process information.

nal strength that is necessary to provide the relevant information of a certain product is $\rho = 1$, which implies an average information cost of $a(1 + \chi a_x/a)/(1 + \chi)$ per product variant. This average cost is declining in χ and thus declines if τ falls. Since $a_x < a$, the global distribution of information to consumers is less expensive than advertising for consumers of each country separately. International trade allows to exploit this scale effects in ICT. In an IU-regime, the effect is used to disseminate information about a larger variety of products so that total advertising expenditure remain constant at the level $M_t a(1 + \chi a_x/a)/(1 + \chi) = L(k - \sigma + 1)/(k\sigma)$. In contrast, in an IS-regime with competition for attention total advertising expenditures are kept at this level by increasing advertising costs per product rather than increasing the variety of products. Formally, the resources lost by wasteful advertising in an IS-regime with $\chi < 1$ are given by the difference

$$\frac{L(k - \sigma + 1)}{k\sigma} - \bar{M}a\frac{1 + \chi a_x/a}{1 + \chi}, \tag{12}$$

which captures the social cost of combative advertising. The waste increases with a fall in the unit costs of transport, since international trade stimulates the competition for attention in an IS-regime and thereby triggers mutual overbidding of advertising expenditures.

Of course, the wasteful competition for attention is not the only distortion induced by the perception constraint in our setting. Regardless of the level of advertising effort, i.e. even at $\rho = 1$, in the IS-regime one important channel for gains from trade is closed, namely the love-of-variety effect. In a model variant in which all firms export, this is irrelevant for the welfare effects of a decline in the iceberg transport cost parameter, because changes in τ do not alter the mass of available varieties in this model variant even if the economy is in an IU regime (see above). Things are different if there is partitioning of firms by their export status (due to $a_x/a > \tau^{1-\sigma}$), where increases in the mass of available varieties is a crucial channel through which gains from trade materialize in an IU-regime. Of course, there is a second channel through which a decline in the iceberg transport cost parameter stimulates welfare in this model variant: The shift of demand from local firms to imports generates productivity gains. But with the gain from a larger variety missing, this may not be sufficient to outweigh possible negative effects of higher total transport cost expenditures due to additional imports. The interaction between limited attention and falling unit costs of trade leads in this case to an inefficient diversion of both consumer attention and consumer expenditures to imports. In other words, importing is excessive.

Taking stock, compared with the IU-regime, in an IS-regime two distortions change

the trade-offs between the benefits and the costs of trade in a setting with partitioning of firms by their export status – wasteful advertising and inefficient diversion of consumers' attention and expenditures to imports.[19] As a result, welfare gains from trade are not guaranteed under limited attention.

For a detailed analysis of the welfare effects under parameter domain $a_x/a > \tau^{1-\sigma}$, we substitute Eq. (6) into Eq. (5) and differentiate the resulting expression with respect to τ. Accounting for (11), we have

$$\left.\frac{dU}{d\tau}\right|_{M_t=\bar{M}} = \frac{U}{(1+\chi)k}\left[1 - \frac{(1-a_x/a)k}{(1+\chi a_x/a)(\sigma-1)}\right]\frac{d\chi}{d\tau}, \tag{13}$$

with derivation details being deferred to the appendix. We see that the welfare implications of trade liberalization crucially depend on the interaction between τ and a_x/a, which reflects the range of ICT. Figure 2 illustrates this. Thereby, we consider $a_x/a < 1$ to ensure that the mass of consumed varieties in an IU-regime does not decrease.[20] If a_x/a is low, domestic advertising information can easily be spread to foreign markets, that means, ICT has a (rather) global range. In this case, a fall in the transport cost parameter generates a strong incentive for initial non-exporters to start exporting, thereby providing a strong stimulus on firm-level advertising. Hence, many low-productivity firms are forced to exit, so that the distortions from wasteful advertising and diversion of consumption towards imports dominate the gains associated with a higher productivity cutoff, and welfare deteriorates if τ shrinks. To put it formally, we call ICT global if $a_x/a < (k-\sigma+1)/(k+\sigma-1)$. Then, according to (13), $dU/d\tau > 0$ under global ICT. This corresponds to the area at the bottom right in Figure 2.

If a_x/a is high, the opposite holds. To be more specific, if $a_x/a > (k-\sigma+1)/k$, we speak of a (rather) local ICT range. In this case, $dU/d\tau < 0$, according to (13). This corresponds to the band at the top of Figure 2. A given reduction in the iceberg transport cost parameter exerts a minor impact on the extensive margin of exporting (χ), and firms will respond to the fall in transport costs with just a small increase in their advertising strength.

[19] It is worth to notice that the two distortions are not an artifact following from our simple modeling of the perception constraint, with a definite limit on the perceptual capacity. They emerge quite generally if perception of additional varieties deteriorates when the supply of varieties reaches a certain level. The deterioration of perception will trigger competition for attention and depress the love-of-variety gains from trade.

[20] We focus on $a_x/a > \tau^{1-\sigma}$ and hence on a parameter domain that generates partitioning of firms by their export status in the subsequent discussion, because we already know from above that welfare increases if τ declines, when all firms export.

Hence, the distortions from wasteful advertising and excessive importing are small, so that gains from trade materialize through the increase in the cutoff productivity level. Finally, if ICT has an intermediate range, i.e. if $(k-\sigma+1)/k > a_x/a > (k-\sigma+1)/(k+\sigma-1)$, we can identify a critical transport cost level[21]

$$\bar{\tau} \equiv \left(\frac{a}{a_x}\right)^{\frac{1}{\sigma-1}} \left[\frac{1}{(a/a_x)\left[k/(\sigma-1)-1\right]-k/(\sigma-1)}\right]^{\frac{1}{k}}, \tag{14}$$

such that $dU/d\tau >, =, < 0$ if $\tau >, =, < \bar{\tau}$. Put differently, a decline in the iceberg transport cost parameter exerts a negative (positive) welfare effect if transport costs have been high (low) initially. See Figure 2 for an illustration.

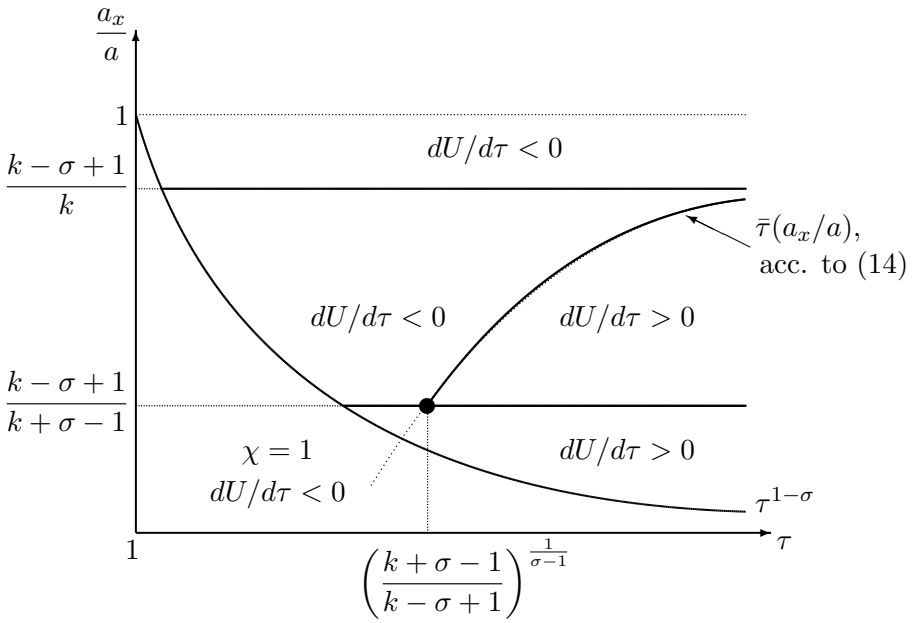

Figure 2: Welfare effects of changes in the iceberg transport cost parameter

The following proposition rounds off the formal discussion in this and the former subsection by summarizing the main insights in a non-technical way.

Proposition 1. *Let $a_x/a > \tau^{1-\sigma}$ and hence partitioning of firms by their export status. Then, a fall in iceberg transport costs may have negative welfare effects in an information-*

[21] Setting the bracket term on the right-hand side of (13) equal to zero and solving the respective expression for χ yields $\chi = (a/a_x)[k/(\sigma-1)-1] - k/(\sigma-1)$. Substitution of $\chi = [(a_x/a)\tau^{\sigma-1}]^{-k/(\sigma-1)}$, then establishes Eq. (14), with $\tau > (a/a_x)^{1/(\sigma-1)}$ being necessary for $\chi < 1$.

saturated regime. Firms, in an endeavor to attract consumers' attention, raise their advertising expenditures. Moreover, the exit of low productivity firms leads to inefficient diversion of demand to imported goods, since love-of-variety gains from trade do not materialize under limited attention. This is in contrast to an information-unsaturated regime, in which a decline in transport costs always generates welfare gains. If $a_x/a \leq \tau^{1-\sigma}$*, then all firms export and a decline in the iceberg transport cost parameter increases welfare in both the information-unsaturated and the information-saturated regime.*

Arkolakis et al. (2012) have pointed out that in a whole class of models used in the new trade theory, including among others Krugman (1980), Eaton and Kortum (2002), and Melitz (2003), the change in welfare in an open economy is directly linked to the change in the share of domestic expenditure, prompting the authors to conclude that the channels through which the gains from trade materialize are not too different in the various theoretical models contributing to the new trade theory. Our model qualifies this conclusion by showing that if the attention of consumers is limited and the capacity to gather and process information exhausted, the welfare effects in models with and without selection of only the best firms into exporting can produce opposite results regarding the welfare effects of trade liberalization.

4 Trade liberalization and taxation of advertising

An immediate question arising from our analysis above is how policy intervention can be designed to establish positive welfare effects of trade liberalization in an IS-regime. Restricting our attention to non-discriminatory policy measures and noting that wasteful advertising is an important source of negative welfare effects, we consider a *uniform* advertising tax as a natural instrument for policy intervention. Furthermore, we assume that the two symmetric countries coordinate their policies and implement the same advertising tax. Focusing on coordinated policies is attractive for two reasons. On the one hand, it avoids complications arising from non-cooperative taxation in a trade model with heterogeneous producers (see Davies and Eckel, 2010). On the other hand, coordination generates the largest potential for welfare-increasing policy effects and thus allows us to answer the question if in an IS-regime welfare gains from trade liberalization can be guaranteed under an optimistic view upon the role of governments in the process of economic integration.

For a proportional tax, with tax rate t, the effective advertising costs for the firm are

$$f = (1+t)a\rho^{\alpha}, \qquad f_x = (1+t)a_x\rho^{\alpha}. \tag{15}$$

Since total advertising expenditures of firms net of tax are given by $Ma\rho^{\alpha}(1+\chi a_x/a)$, the total tax revenue amounts to $T = tMa\rho^{\alpha}(1+\chi a_x/a)$. Whereas T is a component of the fixed production costs of firms which has to be covered by their total revenue, R, it does not require labor resources. That means, total labor demand is now given by $R-T$ rather than by R. It is assumed that the tax is redistributed to consumers via a lump-sum transfer. Thus, their total disposable income is $I = L+T$. With these assumptions at hand, we can derive from $R = I$ the following equation in an analogous way to the derivation of Eq. (4):

$$M_t = \frac{1+\chi}{1+\chi a_x/a}\frac{k-\sigma+1}{\sigma k}\frac{L+T}{a\rho^{\alpha}(1+t)}. \tag{4''}$$

Furthermore, welfare is given by $U = (L+T)/(LP)$, which can be expressed as follows:

$$U = \begin{cases} \frac{L+T}{L}\frac{\sigma-1}{\sigma}\left[\frac{L+T}{\sigma a\rho^{\alpha}(1+t)}\right]^{\frac{1}{\sigma-1}}\left[\left(1+\chi\frac{a_x}{a}\right)\frac{(\sigma-1)a\rho^{\alpha}(1+t)}{(k-\sigma+1)\delta f_e}\right]^{\frac{1}{k}} & \text{if} \quad a_x/a > \tau^{1-\sigma} \\ \frac{L+T}{L}\frac{\sigma-1}{\sigma}\left[\frac{(L+T)\left(1+\tau^{1-\sigma}\right)}{\sigma a\rho^{\alpha}(1+a_x/a)(1+t)}\right]^{\frac{1}{\sigma-1}}\left[\left(1+\frac{a_x}{a}\right)\frac{(\sigma-1)a\rho^{\alpha}(1+t)}{(k-\sigma+1)\delta f_e}\right]^{\frac{1}{k}} & \text{if} \quad a_x/a \leq \tau^{1-\sigma} \end{cases}. \tag{5'}$$

with the last bracketed term in both lines representing the cutoff productivity, ϕ^*, as a function of the tax rate (see Eqs. (2) and (3)).

If the economy is in an IU-regime without taxation, our model features the well-known result that firm entry is allocationally efficient in the Melitz (2003) model (see Melitz and Redding, 2013). Hence, governments that aim at maximizing welfare (5′) set $t = 0$ in the IU-regime. Things are different in an IS-regime, where consumer attention is a scarce resource. In this case, decentralized firm entry is no longer efficient (see above). Governments can improve welfare U by setting a positive tax rate $t > 0$, thereby lowering advertising strength ρ and thus reducing wasteful competition for attention. To be more specific, substituting $T = tMa\rho^{\alpha}(1+\chi a_x/a)$ into (4″), accounting for $M = M_t(1+\chi)^{-1}$, and setting $M_t = \bar{M}$, we can explicitly solve for the strength of advertising in an IS-regime:

$$\rho = \left[\frac{1+\chi}{1+\chi a_x/a}\frac{k-\sigma+1}{k\sigma+t(k+1)(\sigma-1)}\frac{L}{a\bar{M}}\right]^{\frac{1}{\alpha}}. \tag{16}$$

Differentiating (16) with respect to t gives

$$\frac{d\rho}{dt} = -\frac{\rho}{\alpha}\frac{(k+1)(\sigma-1)}{k\sigma+t(k+1)(\sigma-1)}, \tag{17}$$

which is negative and thus confirms the claim that a higher tax lowers the strength of advertising. However, the tax-induced reduction in the strength of advertising does not compensate the direct effect of a higher tax rate on the fixed costs of domestic production, and hence firms face higher fixed costs when t increases.[22] As a consequence, on the one hand, taxation of advertising renders production of the least productive producers unattractive and *ceteris paribus* reduces the mass of firms. On the other hand, higher disposable income and the increased productivity of the marginal firm raise expected profits of the average firm, which makes participation in the productivity lottery more attractive. These two counteracting effects cancel out, leaving the mass of active firms unaffected by changes in t. This can be verified by noting that an IS-regime leads to an advertising strength which makes entry consistent with $M = \bar{M}(1+\chi)^{-1}$, where χ is invariant to a uniform advertising tax. Finally, setting $M_t = \bar{M}$ in $(4'')$, solving for $L+T$ and substituting the resulting expression in $(5')$, we see that

$$\operatorname{sgn}\left[\left.\frac{dU}{dt}\right|_{M_t=\bar{M}}\right] = \operatorname{sgn}\left[\left.\frac{\alpha}{\rho}\,\frac{d\rho}{dt}\right|_{M_t=\bar{M}} + \frac{1}{1+t}\right], \tag{18}$$

which, in view of (17), is positive, since $k > \sigma - 1$ holds by assumption. Hence, in an IS-regime the considered tax instrument is a remedy for the problem of wasteful advertising, and thereby generates positive welfare effects.

Putting together our insights from the policy analysis, we conclude that the welfare-maximizing (non-negative) advertising tax is zero if an IU-regime results in the pre-tax equilibrium, and it is given by[23]

$$\hat{t} = \frac{L(k-\sigma+1) - \sigma k\bar{M}a(1+\chi a_x/a)/(1+\chi)}{(k+1)(\sigma-1)\bar{M}a(1+\chi a_x/a)/(1+\chi)} > 0, \tag{19}$$

otherwise. So far, the results in this section are the same for the model variants with and without partitioning of firms by their export status. This changes, when we consider the impact of adjustments in the iceberg transport cost parameter on the optimal tax rate in Eq. (19). Since the optimal tax corrects for excessive advertising, a pressure to adjust $\hat{t}$ can only materialize if without taxation firms would have adjusted their advertising

[22] Substituting (16) into $f = a\rho^{\alpha}(1+t)$ and differentiating the resulting expression with respect to t gives $df/dt > 0$, since $k > \sigma - 1$ holds by assumption.

[23] The optimal tax in an IS-regime is characterized by the conditions $M_t = \bar{M}$ and $\rho = 1$, and it follows from solving Eq. (16) for t. Using $(4'')$, Eq. (19) can be rewritten as $\hat{t} = \sigma k(L\hat{t}-T)/[(k+1)(\sigma-1)(L+T)]$, which is positive, as the revenue of taxing fixed labor input in advertising, T, is smaller than taxing all labor, $\hat{t}L$.

strength ρ to the changes in τ. As outlined in the previous section, this is only possible in an IS-regime with $\chi < 1$. Otherwise, signal strength ρ would not be affected by changes in τ. Differentiation of Eq. (19) gives $d\hat{t}/d\tau < 0$, implying that in an IS-regime with $\chi < 1$, governments should raise advertising taxes in response to economic integration in order to correct for the social waste of combative advertising, which, according to Eq. (12), increases if transport costs fall. The increase in $\hat{t}$ points to a new channel through which gains from trade can materialize in an IS-regime if $\chi < 1$: higher revenues from advertising taxation. All other things equal, the advertising tax therefore renders positive welfare effects of a transport cost reduction more likely.

However, as shown in the appendix, the optimal tax response to a given change in τ needs not be sufficient for generating positive welfare effects of economic integration, in particular if $\bar{M}$ is relatively low and τ high initially. This might not be surprising at a first glance, because with $a_x/a > \tau^{1-\sigma}$ our model features two distortions that generate waste, excessive (combative) advertising and excessive importing. Therefore, a single instrument can *a priori* not be expected to correct both distortions. However, the two distortions are not independent and both of them are rooted in the limitations of consumer attention. The reason why an optimally designed advertising tax can fail to secure welfare gains of economic integration is that it does not alleviate the perception constraint. As long as this constraint cannot be directly addressed by policy, a successful intervention may require a discriminatory instrument that allows to correct for excessive importing in addition to wasteful advertising. Candidates for such an instrument are an import tariff or a separate advertising tax on foreign exporters. However, both of these candidates would violate the principle of non-discrimination of the WTO, even if they were implemented in a coordinated way in the two economies.

The following proposition summarizes the main insights from the policy analysis.

Proposition 2. *In an information-unsaturated environment, firm entry is efficient, and hence there is no need for policy intervention in the form of an advertising tax. In an information-saturated regime, applying a non-discriminatory and internationally coordinated tax on advertising is a useful instrument to overcome the problem of wasteful advertising. If there is partitioning of firms by their export status, the optimal tax rate increases with economic integration. The instrument is, however, of no help for eliminating the inefficient diversion of consumer purchases to imports under limited attention. Hence, as long as policy intervention accords with the principle of non-discrimination, welfare gains*

from a transport cost reduction are not guaranteed in an IS-regime with $\chi < 1$ even if governments set the advertising tax optimally.

5 Advancements in information and communication technology

In the previous two sections, we have studied the consequences of trade liberalization for optimal taxation and consumer welfare. Thereby, we have shown that the available ICT for the distribution of advertisements is a key determinant of the welfare effects of international integration under limited consumer attention. In the last two decades, ICT itself has been subject to significant changes, with the respective changes being interpreted in the literature as an important stimulus for economic growth (Jorgenson and Vu, 2005; Venturini, 2009) and international trade (Freund and Weinhold, 2004; Fink et al., 2005). It is therefore worthwhile to look at the impact that changes in ICT exert on welfare in our model with limited consumer attention. To shed light on this issue, we distinguish between general ICT advancements, which affect domestic and foreign costs of advertising symmetrically, and advancements that reduce in particular the extra costs of targeting foreign consumers. In our model, the former means that a and a_x decline *pari passu*, while the latter is associated with a decline in a_x for a given a.

We start with a discussion of general advancements in ICT. A proportional reduction in the fixed cost parameters a and a_x lowers, for a given signal strength ρ, firm-level advertising expenditure. This renders firm entry in the domestic and the export market more attractive, without changing the relative attractiveness of the two markets from the perspective of producers. In an IU-regime, the perceptual capacity of consumers is not exhausted, so that the additional products from new entrants (domestic ones or foreign exporters) can be perceived at signal strength $\rho = 1$ and firms do not have an incentive to increase their advertising effort. At the aggregate level, the decline in firm-level advertising expenditure is offset by an increase in the mass of firms that advertise in order to bring their products to the attention of consumers. As a result economy-wide resources used for advertising are not affected by a general advancement in ICT. But a larger content of information can now be transported with these advertising resources. This allows consumers the perception and purchase of additional products which is welfare enhancing, despite a fall in the cutoff productivity level triggered by the entry of new firms at the

bottom of the productivity distribution.

In contrast to this, consumer attention is scarce if the economy is in an IS-regime, and firms raise their advertising effort in response to the technology advancement, as competition for attention is reinforced by additional entry attempts of firms. With the total mass of perceived product varieties being limited by $\bar{M}$, the increase in advertising strength eats up all the benefits from the *pari passu* decline in a and a_x, implying that firm-level fixed costs, the mass of available domestic and imported varieties, and thus welfare remain unaffected by such general advancements in ICT. Put differently, the benefits from technological advancement are offset by the additional waste of resources due to an increase in combative advertising. Introducing the advertising tax from Section 4 can correct for this distortion and, when optimally designed, the tax would thus secure the gains from ICT advancement under an IS-regime (see the appendix for formal details).

We next turn to the analysis of biased ICT change which reduces the extra costs of targeting foreign consumers (export-biased ICT change, in short). The 'Internet revolution' in the early 1990s is a good example for such a change. It has opened a new medium for advertising, with a much more global range than its offline alternatives. Empirical evidence shows that due to its wider range of information dissemination, the internet has attracted a substantial share of total advertising expenditures since the beginning of its commercial use in 1994.[24] In our model, these changes can be captured by a decline in parameter a_x for a given level of a. This interpretation is akin to the conclusion by Freund and Weinhold (2004) that "the Internet reduces market-specific fixed costs of trade" (p. 171).

A fall in cost parameter a_x renders exporting more attractive. In a setting, in which all firms export ($a_x/a < \tau^{1-\sigma}$), this increases the prospects of firms symmetrically, and hence renders production more attractive for all producers. This leads to a decline in ϕ^*. In a model with partitioning of firms by export status ($a_x/a > \tau^{1-\sigma}$), the savings on exporting fixed costs accrue only to high- productivity firms, inducing new firms to start exporting. This intensifies competition for labor and enforces exit of the least productive non-exporters, so that the cutoff productivity, ϕ^*, increases when the fixed costs of exporting fall (see Melitz, 2003).[25] For the effect of a fall in a_x on the mass of available varieties,

[24] Evans (2009) presents empirical evidence that in the US the revenue share for online advertising in total advertising has significantly increased between 2000 and 2008, from 3.2 to 8.8 percent.

[25] Like other equilibrium variables in our model, ϕ^* depends on the term $1 + \chi a_x/a$ (see (27) in the appendix). With $\chi = (a_x/a)^{-k/(\sigma-1)}\tau^{-k}$ we have $\chi a_x/a = (a_x/a)^{(\sigma-1-k)/(\sigma-1)}\tau^{-k}$. For $\chi = 1$ this

we have to distinguish between the two information regimes and the exposure of firms to exporting. In an IU-regime there are two effects on domestic firm entry. On the one hand, firms have easier access to the export market, which raises expected profits and thus renders entry into the productivity lottery more attractive, thereby increasing M. On the other hand, the attractiveness of starting production changes and it does so in different ways in the model variants with and without partitioning of firms by their export status. If $a_x/a < \tau^{1-\sigma}$ leads to exporting of all firms, the cutoff productivity level falls and hence the share of firms that are successful in the productivity lottery goes up, which further increases M. If $a_x/a > \tau^{1-\sigma}$ leads to $\chi < 1$, there is exit of the least productive producers, which lowers M. The latter effect dominates, so that the mass of domestic producers falls if a_x decreases.[26] This negative effect on the mass of domestic firms is counteracted and dominated by an increases in the share of imported varieties χ,[27] so that a decline in a_x establishes a positive impact on the mass of available varieties M_t, irrespective of whether all firm export or not. If $a_x/a > \tau^{1-\sigma}$ and thus $\chi < 1$ welfare increases due to both a higher productivity cutoff and the expansion of available varieties. If $a_x/a < \tau^{1-\sigma}$ the welfare gains from access to a larger mass of varieties dominate losses from a decline in the average productivity of domestic producers caused by the fall in the cutoff productivity level.

In an IS-regime, the equilibrium strength of advertising is determined by Eq. (16), with $t = 0$ in the absence of taxation. Differentiation with respect to a_x yields

$$\left.\frac{d\rho}{da_x}\right|_{M_t=\bar{M}} = \begin{cases} -\dfrac{\rho}{\alpha}\dfrac{\chi}{a_x(1+\chi a_x/a)}\left[\dfrac{1-a_x/a}{1+\chi}\dfrac{k}{\sigma-1}+\dfrac{a_x}{a}\right] & \text{if} \quad a_x/a > \tau^{1-\sigma} \\ -\dfrac{\rho}{\alpha}\dfrac{1}{(a+a_x)} & \text{if} \quad a_x/a < \tau^{1-\sigma} \end{cases}, \tag{20}$$

which is negative, so that each firm advertises with higher signal strength, ρ, when the extra costs of targeting foreign consumers' attention, a_x, shrink.[28] Compared to the IU-regime, additional advertising at the firm level reinforces exit of low-productivity firms,

increases if a_x declines, because all firms already export, whereas for $\chi < 1$ it falls if a_x declines, as $k > \sigma - 1$ holds by assumption, implying that the indirect effect through an expansion of χ dominates the direct effect through a decline in a_x. Note that this argument applies for both the IU- and the IS-regime. Provided that $\chi < 1$ ($\chi = 1$), the $(1 + \chi a_x/a)$-term always rises (declines) if a_x decreases for a given a.

[26] This can be seen by computing $M = M_t/(1+\chi)$, according to Eq. (4′) and noting from above that if $\chi < 1$, then $1 + \chi a_x/a$ increases when a_x falls.

[27] Differentiating Eq. (4′) at $\rho = 1$, confirms this result.

[28] Despite the export bias in ICT advancement, the same (now higher) advertising strength is required in the domestic and the foreign market after a decline in a_x. This is because all firms choose the minimum

thereby increasing cutoff productivity ϕ^* ceteris paribus. If $a_x/a < \tau^{1-\sigma}$ renders exporting attractive for all firms, the increase in the advertising strength exactly compensates for the decline in a_x leaving the fixed costs of firms unaffected. Hence, the combined effect of the decline in a_x and the increase in ρ on the cutoff productivity level is zero, so that neither the mass nor the composition of firms is affected by the decline in a_x in this case. As an immediate consequence of this, welfare also remains unaffected when a_x declines in an IS-regime with $\chi = 1$.

Things are different if $a_x/a > \tau^{1-\sigma}$ leads to partitioning of firms by their export status. In this case, the now stronger selection at the bottom of the productivity distribution in the IU-regime gives an additional welfare stimulus, which, however, is counteracted by an efficiency loss stemming from wasteful advertising and inefficient diversion of purchases towards foreign goods. The latter comes from the fact that the rising imports induce additional transport cost expenditures, on the one hand, but scarcity of consumer attention does not allow to exploit the love-of-variety gains, on the other hand. As shown in the appendix, the two negative distortions – wasteful advertising and diversion of purchases towards imports – dominate in our model, so that an export-biased advancement in ICT leads to a welfare loss in an IS-regime if $\chi < 1$. Following the reasoning in Section 4, a non-discriminatory advertising tax needs not be successful in making an export-biased advancement in ICT beneficial, because it is not suited to target the distortionary diversion of purchases to imports when attention is scarce.[29]

The following proposition summarizes the main insights from our analysis in this section.

Proposition 3. *A general advancement in ICT raises welfare in an IU-regime and leaves welfare unaffected in an IS-regime. An ICT advancement that is biased towards international trade, lowers the fixed costs of exporting and thus generates welfare gains in an IU-regime. In an IS-regime, it intensifies competition for scarce consumer attention and induces wasteful advertising. If all firms export, this eats up all the benefits from the ICT advancement, so that welfare remains unaffected. With partitioning of firms by their export status, it additionally diverts demand to imported goods, thereby lowering welfare. In an IS-regime, a non-discriminatory advertising tax can ensure gains from general ICT progress, but it needs not be successful in securing gains from export-biased ICT progress*

signal strength that brings them to the attention of consumers, and, since the two countries are symmetric, this minimum strength is the same in both markets.

[29] A formal proof of this result can be found in the appendix.

if only the most productive firms export.

6 Further discussion

In Sections 2 and 3, we have introduced a perception constraint into an otherwise standard Melitz (2003) model to study the consequences of limited consumer attention for gains from international integration (brought about by falling unit costs of transport or ICT progress). Thereby, we have assumed that consumers have 'love-of-variety preferences' over all goods, implying that they purchase all available varieties in equilibrium. Whereas this is a common property of models along the lines of Melitz (2003), it is restrictive in our setting, as it rules out one potentially important form of welfare loss in the presence of constrained perception: Distraction of an agent's attention by products that he or she does not want to consume. There is no doubt that we are confronted with a lot of – from our perspective – useless advertising (commonly referred to by the term 'junk'). It is thus of interest to see how the insights from our analysis change if we additionally account for this possibility. Falkinger (2008b) provides a useful starting point for studying the role of junk in a limited attention model, and we now show how the model outlined in Sections 2 and 3 can be extended to capture the welfare losses associated with distraction of attention by junk.

For this purpose, let us assume that there are two types of consumers, $i = 1, 2$, who differ in their assessment of goods. Products can be classified according to the utility they provide to the two types of agents and, for simplicity, we assume that products from category i are associated with positive utility of consumers i, while useless for other ones, i.e. for consumers $-i \neq i$. In this case, consumers from subgroup $-i$ will not purchase goods from category i, irrespective of the price they are confronted with. If consumers would have perfect knowledge about all goods, they would clearly pay only attention to the preferred ones and ignore any advertisements on products they consider as useless. This is the case put forward by Krugman (1980) to illustrate home-market effects on the pattern of trade. However, the very reason for why we have an attention model and why advertising plays a role in the first place is that ex ante consumers are not fully informed about the available products. Hence, it is impossible to filter advertisements perfectly according to consumers' preferences, without paying some attention also to those products which ex post turn out to be useless.

To see the implications of those principle limitations in their clearest form, we dis-

regard any filtering and assume that consumers allocate their attention randomly on all advertisements. For the producer of a particular product, this means that all consumers must be addressed with sufficient strength to attract their attention, but only part of them will purchase the product. This gives us an attention model whose properties are similar to the one studied in the previous sections and, at the same time, accounts for the distraction of attention by products that actually are useless from the perspective of consumers. Of course, the distraction of attention does only trigger welfare losses if the perception constraint is binding, because it is only in this case that attention which is allocated on junk crowds out attention for products that have a positive value for consumers.

The pure existence of welfare losses due to exposure to junk does not change our insights upon the role of limited consumer attention for the gains from trade identified in the previous analysis. This can easily be seen if we consider a situation in which everything is symmetric: Populations of type 1 and 2 consumers are of equal size, firms assigned to the two categories draw productivity from the same distribution, and countries are symmetric in all respects. Then, economic integration will not change the composition of goods from the two product categories and will therefore leave the exposure to junk unaffected in an IS-regime. Hence, the only thing which changes compared to the analysis in the previous sections is for producers, that sales for a successfully advertised product are cut by half, and for consumers, that only half of the perceived products are relevant for the pleasure enjoyed by love of variety. For the competition for attention and thus for selection effects and entry decisions nothing changes qualitatively, so that the insights from the previous analysis are not altered in an essential way.

This changes if we allow for asymmetries in the two countries' population of type 1 and type 2 consumers. Suppose, for instance, that one country is populated only by type 1 consumers, whereas in the other country the population is split into one half of type 1 consumers and one half of type 2 consumers. No type 2 firms enter the country that hosts only type 1 consumers, and hence the consumers in this country experience no junk, irrespective of how deep international integration is. However, international integration changes the composition of available products in the country with both types of consumers with the effect that type 2 consumers experience more junk and type 1 consumers less of it. With an asymmetry of this form and the perception constraint being binding, further economic integration therefore aggravates the attention distraction problem for one subgroup, while lowering it for the other one. This has two notable implications. First, the widespread concern that in recent years the magnitude of junk in advertisement has

enormously increased does not necessarily refer to a general impression of all consumers. Second, there are two counteracting effects on the distraction of attention with the total implications for aggregate welfare depending *inter alia* on the relative size of the two subgroups of consumers.[30]

7 Concluding remarks

This paper has introduced the idea of limited consumer attention into a new trade theory model with love-of-variety preferences and heterogeneous firms. In this setting, we have shown that access to new foreign varieties does not necessarily provide gains from trade. The existence of a positive welfare effect from trade liberalization crucially depends on whether an economy is in an information-unsaturated or in an information-saturated regime and whether there is selection of firms into exporting or not. If all firms export, trade liberalization is always welfare improving, irrespective of how much information consumers are exposed to. Things are different if there is selection of only the best firms into exporting. In this case, a decline in transport costs raises both the mass of consumed varieties and the cutoff productivity level in an information unsaturated regime, thereby triggering positive welfare effects as in other new trade theory models with heterogeneous producers.

In an information-saturated regime, firms raise their advertising expenditures in response to lower transport costs in order to reach consumers in the then fiercer competition for their limited attention. This reinforces the selection effect at the bottom of the productivity distribution and leads to exit of the least productive producers, which brings the mass of supplied varieties in accordance with the perception constraint of consumers. Whereas the rise in the productivity level of active firms is beneficial, the increased advertising efforts of firms – which triggered the additional selection effects – are a waste of resources; they do not expand the set of products perceived by consumers, which is limited by the consumers' capacity to gather and process information in an information-saturated regime. The negative effect of wasteful advertising is complemented by a second distortionary effect: Under scarcity of attention, the love-of-variety gains from trade cannot be exploited and compensate for the higher total transport cost expenditures due to additional imports. This induces inefficient diversion of consumer purchases to imports. In

[30] A further reason why trade may exacerbate the attention distraction problem is a bias of consumer preferences towards domestic products.

sum, a decline in the unit costs of transport can have negative effects on welfare in an information-saturated economy with partitioning of firms by their export status.

In a further step of our analysis, we have looked at the consequences of advancements in information and communication technologies which ease the dissemination of advertisement information. We have shown that the welfare implications of such an advancement depend on two factors: the scarcity of consumer attention and the export bias in the technology improvement. If the economy is in an information-unsaturated regime, both a general and an export-biased advancement in ICT – despite their different effects on the cutoff productivity level – lead to an increase in the mass of available product variants and thus enhance welfare. On the contrary, in an information-saturated regime, firms raise their advertising strength, because an advancement in ICT reinforces competition for scarce consumer attention. In the case of a general advancement, firm-level adjustments in the advertising strength offset the direct positive effect of falling advertising costs, leaving the productivity cutoff and the mass of available domestic and imported varieties at their initial levels. The waste of resources due to combative advertising eats up all the benefits associated with a general advancement in ICT, so that welfare remains unaffected. If the ICT advancement is export biased, its implications are even less encouraging, in particular, if there is selection of only the best firms into exporting. By reinforcing selection at the bottom of the productivity distribution and diverting demand to imports, an export-biased advancement in ICT unambiguously lowers welfare in this case.

We have also studied the scope for policy intervention and have shown that setting an internationally coordinated and non-discriminatory advertising tax is indeed a remedy for the problem of wasteful advertising triggered by competition for attention. If the tax is set optimally, the waste of advertising resources can be eliminated completely, whereby the optimal tax increases with integration. This suffices to ensure gains from general advancements in ICT. But even under an optimal advertising tax, the problem of inefficient diversion of purchases to imports, which arises under limited attention and partitioning of firms by their export status, remains a source of welfare loss. Hence, an optimal adjustment of the advertising tax to changes in transport costs or to export-biased advancements in ICT need not be sufficient to ensure gains from trade. The diversion of purchases to imports provides an argument for discriminatory policy measures, which however would be against the principles of WTO. In an information-unsaturated regime the perception constraint of consumers is not binding and firm entry is efficient, so that there is no need for policy makers to intervene with a (positive or negative) tax on advertisement.

In an extension, we have modified preferences to abandon the restrictive assumption that consumers purchase all goods. To be more specific, we have distinguished consumers according to their assessments of goods and have assumed that consumption of a specific type of goods needs not be beneficial for all consumers. We have shown that the main insights regarding the effects of international integration from our analysis remain unaffected by this modification if consumers allocate their attention randomly on advertisements and everything is symmetric. However, the existence of junk – this means advertisement information about products which are useless for a consumer – clearly leads to additional welfare losses in an information-saturated environment, and in an asymmetric environment these losses may differ between consumer groups.

Whereas the main purpose of this paper is setting up a simple, analytically tractable framework for studying the consequences of limited consumer attention in the context of international trade, our analysis also provides insights for empirical research. In particular, we show that import of new varieties generates a crowding out of domestically produced varieties as in other models of heterogeneous firms. However, with limited consumer attention this crowding out may be sufficiently strong to induce welfare losses. Lacking information on the number of domestic varieties, empirical research exclusively accounts for changes in the number of imported varieties when assessing the welfare effects of trade postulated by the new trade theory (see, for instance, Broda and Weinstein, 2004, 2006). This approach ignores the crowding out of domestic producers, and hence may lead to overly optimistic predictions regarding the existence of gains from trade. According to our model, the size of the crowding out effect is a function of trade costs and advertising expenditures. To be more specific, the model predicts that the crowding out effect is strong if total advertising expenditures relative to GDP increase in response to the import of new varieties (and even more so if the surge in advertising is primarily due to importers). Taking stock, our model suggests that better estimates for the gains from imported varieties can be obtained if one accounts for the endogenous adjustment in advertising expenditures relative to GDP as a proxy for the unobserved strength of the crowding out of domestic firms.

Of course, all of our results have to be interpreted under the usual caveat that a single model cannot capture all facets of the real world. However, with the average consumer in the OECD being exposed to 3000 ads a day (Love and Lattimore, 2009), it is important to take the limitations in the consumers' capacity to gather and process information seriously also in the trade literature. A better understanding of these limitations will lead us to a

more realistic picture about the consequences of international integration and its challenges for economic policy. Whereas more research on this topic is certainly needed, we hope that our analysis provides a useful first step for modeling limited consumer attention in an international trade context and for stimulating new empirical research on the gains from imported varieties.

Appendix

Derivation details for Eq. (3)

Let us first consider a parameter domain with $f_x/f > \tau^{1-\sigma}$ and thus $\chi < 1$. In this case, *domestic* profits of exporters and non-exporters are given by

$$\pi(\phi) = \frac{r(\phi)}{\sigma} - f = f\left[\frac{r(\phi)}{r(\phi^*)} - 1\right] = f\left[\left(\frac{1}{\phi}\right)^{1-\sigma}(\phi^*)^{1-\sigma} - 1\right], \tag{21}$$

where $\pi(\phi^*) = 0$ and $r(\phi)$ from Footnote 11 have been used. Note further that for the Pareto distribution $\mathbb{E}[\phi^{-z}] = k/(k+z)$, if $k > -z$, and use $\mathbb{E}[\phi^{-z}|\phi \geq \phi^*] = (\phi^*)^{-z}\mathbb{E}[\phi^{-z}]$. Setting $z = 1-\sigma$ and substituting the resulting expression into (21), we can compute average domestic profits of all active producers: $\bar{\pi} = f(\sigma-1)/[k-\sigma+1]$. In an analogous way, *exporting* profits can be calculated, noting that exporting revenues are $r_x(\phi) = \tau^{1-\sigma}r(\phi)$, whereas exporting fixed costs are f_x. This gives $\bar{\pi}_x = f_x(\sigma-1)/[k-\sigma+1]$. Since only a share χ of firms export, average total profits are given by $\bar{\pi}_t = \bar{\pi} + \chi\bar{\pi}_x$, which can be written in the form of Eq. (3).

If $f_x/f \leq \tau^{1-\sigma}$, all firms export, so that *total* profits of firms are given by

$$\begin{aligned}\pi_t(\phi) &= \frac{(1+\tau^{1-\sigma})r(\phi)}{\sigma} - (f+f_x) = (f+f_x)\left[\frac{r(\phi)}{r(\phi^*)} - 1\right] \\ &= (f+f_x)\left[\left(\frac{1}{\phi}\right)^{1-\sigma}(\phi^*)^{1-\sigma} - 1\right],\end{aligned} \tag{22}$$

where $\pi_t(\phi^*) = (1+\tau^{1-\sigma})r(\phi^*)/\sigma - (f+f_x) = 0$ has been used. Following the same reasoning as above, we then obtain $\bar{\pi}_t = (f+f_x)(\sigma-1)/[k-\sigma+1]$, which coincides with Eq. (3), when setting $\chi = 1$.

Derivation details for Eq. (5)

The cost-of-living (CES) price index is given by

$$P = \left[M \int_{\phi^*}^{\infty} p(\phi)^{1-\sigma} \frac{dG(\phi)}{1-G(\phi^*)} + \chi M \int_{\phi_x^*}^{\infty} (\tau p(\phi))^{1-\sigma} \frac{dG(\phi)}{1-G(\phi_x^*)} \right]^{\frac{1}{1-\sigma}}$$
$$= \left[\frac{Mk\left(1+\chi\tau^{1-\sigma}(\phi_x^*/\phi^*)^{\sigma-1}\right)}{k-\sigma+1} \right]^{\frac{1}{1-\sigma}} p(\phi^*), \tag{23}$$

where the properties of the Pareto distribution, which were mentioned above, have been exploited. Accounting for $M = M_t/(1+\chi)$ and Eq. (4), and noting that $U = P^{-1}$, we get

$$U = \left[\frac{L\left(1+\chi\tau^{1-\sigma}(\phi_x^*/\phi^*)^{\sigma-1}\right)}{\sigma f(1+\chi f_x/f)} \right]^{\frac{1}{\sigma-1}} p(\phi^*)^{-1}. \tag{24}$$

If $f_x/f > \tau^{1-\sigma}$, we have $\tau^{1-\sigma}(\phi_x^*/\phi^*)^{\sigma-1} = f_x/f$ and Eq. (24) reduces to

$$U = \left[\frac{L}{\sigma f} \right]^{\frac{1}{\sigma-1}} p(\phi^*)^{-1}. \tag{25}$$

In contrast, $f_x/f \leq \tau^{1-\sigma}$ implies $\chi = \phi_x^*/\phi^* = 1$ and thus

$$U = \left[\frac{L\left(1+\tau^{1-\sigma}\right)}{\sigma f(1+f_x/f)} \right]^{\frac{1}{\sigma-1}} p(\phi^*)^{-1}. \tag{26}$$

Solving Eqs. (2) and (3) for ϕ^* and substituting the resulting expression into $p(\phi^*) = [\sigma/(\sigma-1)](\phi^*)^{-1}$, we obtain

$$p(\phi^*) = \frac{\sigma}{\sigma-1} \left[\left(1+\chi\frac{f_x}{f}\right) \frac{(\sigma-1)f}{(k-\sigma+1)\delta f_e} \right]^{-\frac{1}{k}}. \tag{27}$$

Using the latter in (25) and (26), we finally get Eq. (5).

Derivation details for Eq. (13)

Let $\rho \equiv \rho(\chi, M_t)$ be implicitly defined by (4′). Then, substitution of Eq. (6) for f and f_x into Eq. (5) and differentiation of the resulting expression with respect to τ gives us

$$\left.\frac{dU}{d\tau}\right|_{\rho=\rho(\chi,\bar{M})} = \left[\left.\frac{\partial U}{\partial \rho}\right|_{\rho=\rho(\chi,\bar{M})} \times \left.\frac{\partial \rho}{\partial \chi}\right|_{M_t=\bar{M}} + \left.\frac{\partial U}{\partial \chi}\right|_{\rho=\rho(\chi,\bar{M})} \right] \frac{d\chi}{d\tau}. \tag{28}$$

Accounting for (11) and using

$$\left.\frac{\partial U}{\partial \rho}\right|_{\rho=\rho(\chi,\bar{M})} = -\frac{\alpha U}{\rho(\chi,\bar{M})k}\frac{k-\sigma+1}{\sigma-1}, \tag{29}$$

we obtain

$$\left.\frac{\partial U}{\partial \rho}\right|_{\rho=\rho(\chi,\bar{M})} \times \left.\frac{\partial \rho}{\partial \chi}\right|_{M_t=\bar{M}} = -\frac{U(1-a_x/a)}{k(1+\chi)(1+\chi a_x/a)}\frac{k-\sigma+1}{\sigma-1}. \tag{30}$$

Substituting the latter together with

$$\left.\frac{\partial U}{\partial \chi}\right|_{\rho=\rho(\chi,\bar{M})} = \frac{(a_x/a)U}{k(1+\chi a_x/a)}, \tag{31}$$

into Eq. (28) and rearranging terms, establishes Eq. (13).

Welfare effects of trade liberalization under optimal advertising taxation

In the subsequent, we analyze how a decline in the transport cost parameter affects welfare in an IS-regime if the government adjusts its tax policy optimally. Thereby, we focus on a parameter domain with $a_x/a > \tau^{1-\sigma}$ and hence the case of partitioning of firms by their export status.[31] For this purpose, we can first note that setting $M_t = \bar{M}$ in Eq. (4″) yields

$$\frac{L+T}{\sigma a \rho^{\alpha}(1+t)} = \frac{k\bar{M}}{k-\sigma+1}\frac{1+\chi a_x/a}{1+\chi}. \tag{32}$$

We can also use Eq. (4″) to compute

$$(1+\chi a_x/a)a\rho^{\alpha}(1+t) = \frac{k-\sigma+1}{\sigma k}\frac{(1+\chi)(L+T)}{\bar{M}} \tag{33}$$

Substituting $\hat{t}$ from Eq. (19) into Eq. (4″) and accounting for $\rho = 1$ gives

$$T = t\bar{M}a\frac{1+\chi a_x/a}{1+\chi} = \frac{L(k-\sigma+1) - \sigma k\bar{M}a(1+\chi a_x/a)/(1+\chi)}{(k+1)(\sigma-1)}$$

and thus

$$L+T = \frac{k\sigma}{(k+1)(\sigma-1)}\left[L - \bar{M}a\frac{1+\chi a_x/a}{1+\chi}\right]. \tag{34}$$

[31] The welfare effects for the parameter domain with $a_x/a \leq \tau^{1-\sigma}$ and thus $\chi = 1$ must be positive, because with all firms exporting there are welfare gains from a fall in τ even if the tax rate stays constant. Hence, an optimal adjustment of the tax rate can only increase the gains from trade in this case.

Substitution of the expressions above into Eq. (5′) gives

$$U = B\,(1+\chi)^{\frac{1}{k}} \left(\frac{1+\chi a_x/a}{1+\chi}\right)^{\frac{1}{\sigma-1}} \left[L - \bar{M}a\frac{1+\chi a_x/a}{1+\chi}\right]^{\frac{k+1}{k}}, \tag{35}$$

with

$$B \equiv \frac{k}{(k+1)L}\left(\frac{k\bar{M}}{k-\sigma+1}\right)^{\frac{1}{\sigma-1}} \left[\frac{1}{(k+1)\bar{M}\delta f_e}\right]^{\frac{1}{k}}.$$

By definition, an economy is in an IS-regime if the right-hand side of Eq. (4) exceeds $\bar{M}$ at $\rho = 1, t = 0$. Rearranging terms, we can formulate $L(1+\chi)(k-\sigma+1)/(\sigma k) > \bar{M}a(1+\chi a_x/a)$ and, in view of $k-\sigma+1 < k\sigma$, $L(1+\chi) > \bar{M}a(1+\chi a_x/a)$ as a prerequisite for an IS-regime. This implies that Eq. (35) is positive.

Differentiating Eq. (35) with respect to τ, we obtain

$$\frac{dU}{d\tau} = A(\chi)\left[\left(1 - \frac{(1-a_x/a)k}{(1+\chi a_x/a)(\sigma-1)}\right)\left(L - \bar{M}a\frac{1+\chi a_x/a}{1+\chi}\right) + \frac{(k+1)\bar{M}a(1-a_x/a)}{1+\chi}\right]\frac{d\chi}{d\tau}, \tag{36}$$

with

$$A(\chi) \equiv \frac{U}{k\left[L(1+\chi) - \bar{M}a(1+\chi a_x/a)\right]} > 0. \tag{37}$$

Note that $A(\chi) > 0$ follows from $L(1+\chi) > \bar{M}a(1+\chi a_x/a)$, which must hold in an IS-regime (see above). From (14) it follows that $\tau \leq \bar{\tau}$ is equivalent to

$$\frac{k(1-a_x/a)}{(1+\chi a_x/a)(\sigma-1)} \leq 1, \tag{38}$$

which, in view of $d\chi/d\tau < 0$, is sufficient (not necessary) for $dU/d\tau < 0$. We can thus conclude that in an IS-regime $\tau \leq \bar{\tau}$ is sufficient (not necessary) for a positive welfare effect of a marginal decline in transport cost parameter τ if the government adjusts its tax rate according to Eq. (19). However, positive welfare effects of trade liberalization are not guaranteed if $\tau > \bar{\tau}$. In this case, the first component in the square bracket of Eq. (36) is negative, and a marginal decline in τ lowers welfare if $\bar{M}$ is sufficiently small.

Derivation details for Eq. (20)

Setting $t = 0$ and differentiating Eq. (16) with respect to a_x gives

$$\frac{d\rho}{da_x} = \frac{\partial\rho}{\partial a_x} + \frac{\partial\rho}{\partial\chi}\frac{d\chi}{da_x}, \tag{39}$$

with

$$\frac{\partial \rho}{\partial a_x} = -\frac{\rho}{\alpha} \frac{\chi}{a(1+\chi a_x/a)}, \qquad \frac{\partial \rho}{\partial \chi} = \frac{\rho}{\alpha} \frac{1-a_x/a}{(1+\chi a_x/a)(1+\chi)}. \tag{40}$$

If $a_x/a < \tau^{1-\sigma}$, we have $\chi = 1$, and hence the second derivative of Eq. (39) vanishes. This establishes the second line in Eq. (20). If $a_x/a > \tau^{1-\sigma}$, we have $\chi = \left[(a_x/a)\tau^{\sigma-1}\right]^{-k/(\sigma-1)} < 1$, which implies $d\chi/da_x = -[k/(\sigma-1)]\chi/a_x$. Thus, we can rewrite Eq. (39) in the following way:

$$\frac{d\rho}{da_x} = -\frac{\rho}{\alpha} \frac{\chi}{a(1+\chi a_x/a)} - \frac{\rho}{\alpha} \frac{k}{\sigma-1} \frac{(1-a_x/a)\chi}{a_x(1+\chi a_x/a)(1+\chi)}. \tag{41}$$

Rearranging terms, finally gives the first line in Eq. (20).

The implications of ICT advancements

General ICT-advancement

Let us first consider the effect of a *pari passu* decline in both a and a_x. Setting $\rho = 1$ and differentiating Eq. (4′) with respect to a (holding a_x/a constant), we find that $dM_t/da < 0$ holds in an IU-regime. In contrast, setting $M_t = \bar{M}$, we conclude from Eq. (4′) that, for a given a_x/a, $d\rho/da < 0$, while $a\rho^\alpha = const.$ in an IS-regime. The welfare effects of a general advancement in ICT follow immediately from $dU/df < 0$ due to $k > \sigma - 1$, when keeping f_x/f constant (see Eq. (5)). With $f = a\rho^\alpha$ rising in a in an IU-regime, in which $\rho = 1$, while remaining constant in the IS-regime, we confirm that a general advancement in ICT raises welfare under IU and has no effect under IS. Let us now investigate the role of policy intervention. Considering the same tax instrument as in Section 4, the optimal tax level is given by Eq. (19), whereas welfare with optimal advertising taxation is represented by Eq. (35). Differentiating Eq. (35) with respect to a (keeping a_x/a constant) establishes $dU/da < 0$. This implies that general ICT progress unambiguously increases welfare in the IS-regime if advertising taxation is optimally adjusted.

Export-biased ICT-advancement

The impact of an export-biased ICT change on M_t in an IU-regime can be determined by setting $\rho = 1$ and differentiating Eq. (4′) with respect to a_x. This gives

$$\frac{dM_t}{da_x} = \frac{\partial M_t}{\partial \chi} \frac{d\chi}{da_x} + \frac{\partial M_t}{\partial a_x}. \tag{42}$$

If $a_x/a < \tau^{1-\sigma}$, we have $\chi = 1$ and thus $dM_t/da_x = -M_t/(a + a_x)$. If $a_x/a > \tau^{1-\sigma}$, we have $\chi < 1$ and thus

$$\frac{dM_t}{da_x} = -\frac{M_t}{1 + \chi a_x/a} \frac{\chi}{a_x} \left[\frac{k}{\sigma - 1} \frac{1 - a_x/a}{1 + \chi} + \frac{a_x}{a} \right], \tag{43}$$

In both cases, we get $dM_t/da_x < 0$ in an IU-regime. In an IS-regime, we have $M_t = \bar{M}$ and ρ responds to changes in a_x according to Eq. (20).

The welfare implications of an export-biased ICT change in an IU-regime can be determined by substituting Eq. (6) and $\rho = 1$ into Eq. (5) and differentiating the resulting expression by a_x. This gives

$$\frac{dU}{da_x} = \frac{\partial U}{\partial \chi} \times \frac{d\chi}{da_x} + \frac{\partial U}{\partial a_x}, \tag{44}$$

which, in view of the second line of Eq. (5), reduces to

$$\frac{dU}{da_x} = -\frac{k - \sigma + 1}{k(\sigma - 1)} \frac{U}{a + a_x} < 0, \tag{45}$$

if $a_x/a < \tau^{1-\sigma}$. Using (31) and $d\chi/da_x = -k\chi/[(\sigma - 1)a_x]$ for $\partial U/\partial \chi \times d\chi/da_x$, and the first line of Eq. (5) for computing $\partial U/\partial a_x = U\chi/[ak(1 + \chi a_x/a)]$, we obtain

$$\frac{dU}{da_x} = -\frac{U\chi/a}{k(1 + \chi a_x/a)} \frac{k - \sigma + 1}{\sigma - 1} < 0, \tag{46}$$

if $a_x/a > \tau^{1-\sigma}$. Hence, an export-biased advancement in ICT generates welfare gains in an IU-regime.

In an IS-regime with $a_x/a < \tau^{1-\sigma}$, firm-level adjustments in ρ establish $(a_x + a)\rho^\alpha = const.$. In this case, $dU/da_x = 0$ follows from Eq. (5) and an optimal adjustment of the advertising tax rate must therefore be welfare-improving. In an IS-regime with $a_x/a > \tau^{1-\sigma}$, $\rho \equiv \rho(\chi, \bar{M})$ is given by Eq. (16), when setting $t = 0$, and the impact of a change in technology parameter a_x is determined by

$$\left.\frac{dU}{da_x}\right|_{\rho=\rho(\chi,\bar{M})} = \left.\frac{\partial U}{\partial \rho}\right|_{\rho=\rho(\chi,\bar{M})} \times \left.\frac{d\rho}{da_x}\right|_{M_t=\bar{M}} + \left.\frac{\partial U}{\partial \chi}\right|_{\rho=\rho(\chi,\bar{M})} \times \frac{d\chi}{da_x} + \left.\frac{\partial U}{\partial a_x}\right|_{\rho=\rho(\chi,\bar{M})}, \tag{47}$$

which – by using Eqs. (20) and (29) for $\partial U/\partial \rho|_{\rho=\rho(\chi,\bar{M})} \times d\rho/da_x|_{M_t=\bar{M}}$, Eq. (31) and $d\chi/da_x = -k\chi/[(\sigma - 1)a_x]$ for $\partial U/\partial \chi|_{\rho=\rho(\chi,\bar{M})} \times d\chi/da_x$, and Eq. (5) for computing $\partial U/\partial a_x|_{\rho=\rho(\chi,\bar{M})} = U\chi/[ak(1 + \chi a_x/a)]$ – can be reformulated to

$$\left.\frac{dU}{da_x}\right|_{M_t=\bar{M}} = \frac{U\chi/a_x}{(\sigma - 1)(1 + \chi a_x/a)} \frac{k - \sigma + 1}{\sigma - 1} \frac{1 - a_x/a}{1 + \chi} > 0, \tag{48}$$

implying that an export-biased advancement in ICT lowers welfare in an IS-regime.

To determine for $a_x/a > \tau^{1-\sigma}$, the welfare effects of export-biased ICT progress under optimal adjustment of advertising taxation, we differentiate Eq. (35) with respect to a_x. This gives

$$\frac{dU}{da_x} = \frac{\partial U}{\partial \chi}\frac{d\chi}{da_x} + \frac{\partial U}{\partial a_x}, \tag{49}$$

where

$$\frac{\partial U}{\partial \chi}\frac{d\chi}{da_x} = -A(\chi)\left[\left(1 - \frac{(1-a_x/a)k}{(1+\chi a_x/a)(\sigma-1)}\right)\left(L - \bar{M}a\frac{1+\chi a_x/a}{1+\chi}\right) + \frac{(k+1)\bar{M}a(1-a_x/a)}{1+\chi}\right]\frac{k}{\sigma-1}\frac{\chi}{a_x} \tag{50}$$

and

$$\frac{\partial U}{\partial a_x} = A(\chi)\left[\frac{k}{\sigma-1}\,\frac{1+\chi}{1+\chi a_x/a}\left(L - \bar{M}a\frac{1+\chi a_x/a}{1+\chi}\right) - (k+1)\bar{M}a\right]\frac{\chi}{a}, \tag{51}$$

with $A(\chi)$ being defined in Eq. (37). Collecting terms, we can compute

$$\frac{dU}{da_x} = \frac{A(\chi)\chi}{a_x}\left[\frac{k-\sigma+1}{\sigma-1}\frac{(1-a_x/a)k}{(1+\chi a_x/a)(\sigma-1)}\left(L - \bar{M}a\frac{1+\chi a_x/a}{1+\chi}\right) - (k+1)\bar{M}a\left(\frac{1-a_x/a}{1+\chi}\frac{k}{\sigma-1} + \frac{a_x}{a}\right)\right]. \tag{52}$$

From the discussion of Eq. (37) we know that $L(1+\chi) > \bar{M}a(1+\chi a_x/a)$ must hold in an IS-regime, implying that $A(\chi) > 0$. Hence, welfare increases in a_x if a_x/a and $\bar{M}$ are sufficiently small. This shows that export-biased advancements in ICT may reduce welfare in our model, even if advertising taxation is optimally adjusted.

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